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Development of An Automatic Bumper And Braking System For Vehicles Using Pneumatics System To Avoid Collision

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Abstract

Now-a-days, accidents taking place are very frequent in India which occur mainly due to the inefficiency of driver to apply brakes at the right time. To prevent the accident, there is no provision to apply brakes when the driver fails. Also, In currently used vehicles generally bumpers used are of rigid types. These bumpers have specific capacity and when the range of the accidental force is very high then the bumper fails and the force is transferred towards the passengers. So the current system never reduces the damage of both vehicle and passengers. To overcome these two problems development of automatic bumper and braking is important. Therefore, the aim is to design and develop an electronically intelligent braking system which can automatically sense the objects ahead of the vehicle and applies brakes itself to avoid collision. The system also activates extractable bumper which may extract and reduces the damage to the vehicle's body. This bumper may extract or retract with the help of using Pneumatics technology which is much easier to implement and is readily available easily. Automatic braking system use the infrared sensor (IR), which is used to sense the vehicle coming from front of our vehicle and which is responsible for accident. Then sensor sends feedback signal to the control unit and activates the solenoid valve. When the solenoid valve gets actuated the compressed air goes to the pneumatic cylinder and actuates it. During the working of Automatic braking system simultaneously the control unit activates the pneumatic bumper system to reduce the damage to vehicle which occurs in accidents. This system provides pre-crash safety to the vehicle

Keywords — *Brake, Bumper, Vehicles, Driver, Pneumatics.*

I. INTRODUCTION

The population of our country has been increasing rapidly which indirectly increases the vehicle density and leads to many road accidents. The aim of the project in to minimize the road accidents which causes the loss of invaluable human life and other valuable goods. Safety is a necessary part of man's life. It is expected that if such a device is designed and incorporated into our cars as a road safety device, it will reduce the incidence of accidents on our roads and various premises, with subsequent reduction in loss of life and property. Over 1, 51,000 people were killed in road accidents in the last year alone, that is more than the number of people killed in all our wars put together. The obtained results show that high rate of accident is reported each year. One serious road accident in the country occurs every minute and 17 die on Indian roads every hour. 1317 road crashes occur every day in India. A lot of cases reported is as a result of drivers sleeping off while driving, and when he/she eventually woke up, a head-on collision might have taken place. Not many have had the fortune to quickly avert this. It is therefore imperative to consider the advantages of an early warning system where the driver is alerted of a possible collision with some considerable amount of time before it occurs.

The technology of pneumatics has gained tremendous importance in the field of workplace rationalization and automation from old-fashioned timber works and coal mines to modern machine shops and space robots. It is therefore important that technicians and engineers should have a good knowledge of pneumatic system, air operated valves and accessories. The aim is to design and develop a control system based an intelligent electronically controlled system called "Development of an Automatic Bumper and Braking System for Vehicles using Pneumatic System to avoid Collision" .This system consists of IR transmitter and Receiver circuit, Control Unit, Pneumatic bumper system and braking system. The IR sensor is used to detect the obstacle. There is any obstacle closer to the vehicle, the control signal is given to the bumper activation system. The pneumatic bumper system is used to protect the man and vehicle.

Automotive safety is intentionally to avoid vehicle accident or reducing the effect of accident especially to the human body including the driver, passengers and pedestrians Moreover, some of the safety features are also purposely to reduce vehicle damages in order to minimize the repairing cost. Active safety in vehicle system uses the information of vehicle external environment and the system will response accordingly to the situation during the phase of pre-crash or during the crash event. This is will either avoid the crash from happen or increase the safety of the vehicle by reducing the crash effect. Passive safety in the other hand is a system that only works to prevent injury but not change the vehicle action in response to crash scenario. The examples of the passive safety are like airbag, crumple zone, seat belt and passive automotive bumper. A metal or plastic shell that is filled with a foam energy absorbing block of polypropylene or foam normally used in an automotive low-impact absorbing bumper construction, and is mounted to the vehicle on a relatively rigid beam. The kinetic energy from the collision will be absorbed by the foam energy absorbing material through the deformation of the bumper structure. Many researches have been made regarding to the bumper deformation characteristic and absorption capability. Usually the research is concentrating on the selection of the bumper material like aluminium and composites.which are dependable, require lower conservation and have lower specific fuel consumption.

II. OBJECTIVE

The objective of the project is to ensure safety of vehicles and all the passengers it is carrying by the use of electronically operated intelligent braking and bumper system. The aim of the project is to minimize the road accidents which causes the loss of invaluable human life and other valuable goods. Following are the main objectives of Automatic System with Pneumatic Bumpers

1) To increase the safety during pre-crash.

2) To increase the crashing distance during accident.

3) To decrease the level of passenger injury by use of external vehicle safety device.

4) To increase external safety to vehicle body.

specification of the test engine used for the present work is given in Table I as follow

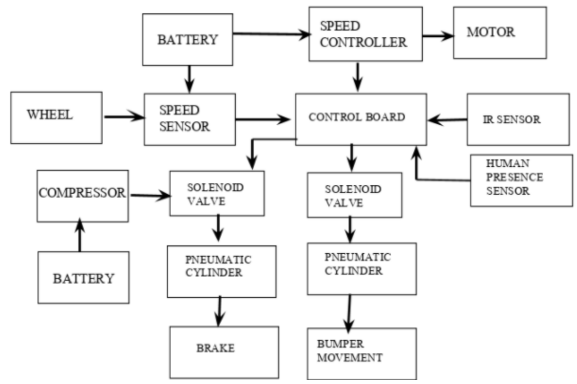

Fig.1 Block diagram

III. COMPONENTS AND MATERIAL SELECTION

TABLE 1
Components Required

1. Mild Steel Frame	10. D6T Thermal sensor	19. Chain
2. Battery	11.Arduino board	20. Axles
3. DC Motor	12.LCD display	21. Bearings
4. Disk Brake	13. T-joint	22. Nut and Bolts
5. PCB	14. Double acting cylinder	23. IR sensor circuit
6. 5/2 Solenoid Valve	15. Wheels	24. Sliding channel
7. Compressor	16. Sprocket	25. Relays
8.IR speed sensor	17. Bearing	26. Electrical cables
9.DC motor speed controller using PWM	18.Pneumatic hose	27.Jumper cables

A. COMPONENT DETAILS

a) Compressor

A compressor can compress air to the required pressures. It can convert the mechanical energy from motors and engines into the potential energy in compressed air (Fig.2). A single central compressor can supply various pneumatic components with compressed air, which is transported through pipes from the cylinder to the pneumatic components. Compressors can be divided into two classes: reciprocating and rotary. Specification: Voltage-12v, Max.current-14A, Max. Pressure- 150PSI & Displacement-35L/min.

Fig .2 Compressor

b) DC Motor

The modern DC motor was invented by accident in 1873, when Zénobe Gramm connected a spinning dynamo to a second similar unit, driving it as a motor.The classic DC motor has a rotating armature in the form of an electromagnet. A rotary switch called a commutator reverses the direction of the electric current twice every cycle, to flow through the armature so that the poles of the electromagnet push and pull against the permanent magnets on the outside of the motor. As the poles of the armature electromagnet pass the poles of the permanent magnets, the commutator reverses the polarity of the armature electromagnet. During that instant of switching polarity, inertia. A simple DC electric motor is shown in Fig.3. When the coil is powered, a magnetic field is generated around the armature. The left side of the armature is pushed away from the left magnet and drawn toward the right, causing rotation. Model-Voltage :12V,No Load Current ≤220 mA,No load Speed 60 RPM (at 12V),Full Load Current (mA) ≤1300,Rated Current ≤4800 mA ,Rated Torque (Kg-cm)-40,Shaft Diameter-8mm.

Fig. 3 DC Motor

c) Double acting cylinder

In a double acting cylinder, air pressure is applied alternately to the relative surface of the piston, producing a propelling force and a retracting force (Fig. 4). As the effective area of the piston is small, the thrust produced during retraction is relatively weak. The impeccable tubes of double acting cylinders are usually made of steel. The working surfaces are also polished and coated with chromium to reduce friction. Model-MAL20x50 and MAL20x100, Pressure-0.1-to 10 bar.

Fig .4 Double acting cylinder

d) Mechanical Disc Brake

Mechanical discs use the same cables and housing found on traditional cantilevers and V- brakes (Fig.5). Cables offer certain advantages over hydraulic systems, including simpler installation and adjustment, lighter weight, and less complicated maintenance (cables can be found at any bike shop and are less expensive than hydraulic lines). The main drawback to mechanical brakes is cable stretch, which causes a spongy feel, reduces braking force and requires frequent adjustment. Cables and housing are also susceptible to rust, dirt, and debris build-up that can bind the braking system. These problems are completely avoidable though. Specification:Diameter-150mm,Mindia-mm,Thickness-1.9mm,PCD-48mm,Material-Toughened steel.

Fig. 5 Mechanical disc brake

e) Photoelectric Sensor

A sensor is a transducer used to make a measurement of a physical variable. Any sensor requires calibration in order to be useful as a measuring device. Calibration is the procedure by which the relationship between the measured variable and the converted output signal is established. Care should be taken in the choice of sensory devices for particular tasks. The operating characteristics of each device should be closely matched to the task for which it is being utilized.

Different sensors can be used in different ways to sense same conditions and the same sensors can be used in different ways to sense different conditions. Photoelectric sensor is shown in Fig.6. Model:TP-E18-3A30PA, Range:0-300mm, Make: taper.

Fig .6 Photoelectric sensor

f) Solenoid Valve

The directional valve is one of the important parts of a pneumatic system. Commonly known as DCV as shown in Fig.7, this valve is used to control the direction of air flow in the pneumatic system. The directional valve does this by changing the position of its internal movable part. A solenoid is an electrical device that converts electrical energy into straight line motion and force. These are also used to operate a mechanical operation which in turn operates the valve mechanism. Solenoids may be push type or pull type. The push type solenoid is one in which the plunger is pushed when the solenoid is energized electrically. The pull type solenoid is one is which the plunger is pulled when the solenoid is energized.Model:3V210-08,Pressure:1.5-8bar.

Fig .7 Solenoid valve

g) D6T Thermal Sensor

D6T series sensors(Fig.8) can detect human presence by sensing changes in human body temperature with respect to the surrounding temperature. It has a huge number of applications including body temperature measurement and movement detection. The sensor has a field of view of 90 degrees and returns the average temperature value of all objects within this field of view.

A non-contact infrared thermometer for use with Arduino, or any microcontroller that can communicate with it through its I2C interface.. D6T sensors are used to measure temperature without the need to physically touch the object. Unlike pyroelectric sensor that relies on motion detection, non-contact MEMS thermal sensor is able to detect the presence of stationary humans (or objects). The MLX90614 ESF is an Infra-Red thermometer for non-contact temperature measurements. Both the IR sensitive thermopile detector chip and the signal conditioning ASIC are integrated into the same TO-39 can. The Integrated MLX90614 GY-906 is a low noise amplifier, 17-bit ADC, and powerful DSP unit thus achieving high accuracy and resolution of the thermometer.

Fig .8 D6T Thermal sensor

h) Motor Speed Controller:

This DC Motor Speed Controller shown in Fig.10 allows controlling the speed of a DC motor using a Pulse--Width-Modulated (PWM) DC voltage with a Duty Cycle fully adjustable from 0%-100%.The motor speed controller can easily provide a continuous current of 3A to the DC motor.Connect the DC motor (or DC load) to the motor terminals as indicated on the wiring diagram.Connect a voltage of 10V-36V DC to the circuit making sure of the correct polarity of the connection. Note that the voltage applied to the motor will be supply voltage applied to the circuit.

Fig .9 Motor speed controller

i) IR Speed Sensor

The motor speed sensor module shown in Fig4.9 is a simple device that yields processed pulse trains when the visual path of its optical sensor is physically interrupted by some sort of slotted wheel or similar mechanism (an optical sensor commonly consists of a light emitting diode that provides the illumination, and a phototransistor that senses the presence or absence of that illumination). The transmissive optical sensor used here consists of an infrared light emitting diode and a phototransistor. This both prevents interference from stray external light sources and by having the two components matched for a specific frequency of radiation, they are even more immune to undesired interference.

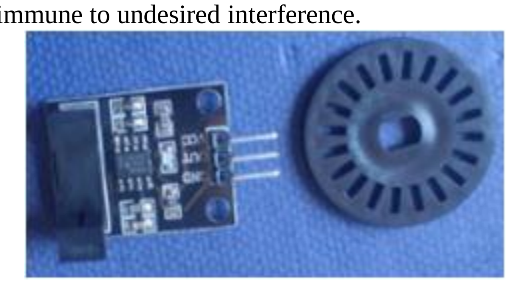

Fig .10 IR Speed sensor

j) Arduino:

The Arduino UNO rev.3, it is a microcontroller board based on 8-bit ATmega328P microcontroller. As shown on Fig.11, It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.The board can operate on an external supply from 6 to 20 volts.The recommended range is 7 to 12 volts. The Arduino Uno board can be powered via the USB connection or with an external power supply. The power source is selected automatically.

Specification:
Operating Voltage: 5V
Input Voltage (recommended): 7-12V
Input Voltage (limits): 6-20V
Digital I/O Pins: 14 (of which 6 provide PWM output)
Analog Input Pins: 6
DC Current per I/O Pin: 40 mA
DC Current for 3.3V Pin: 50 mA
Clock Speed: 16 MHz

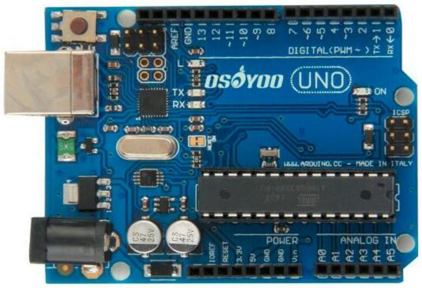

Fig .11 Arduino

k) LCD Display

LCD1602 provides a 16×2 White on RGB Liquid Crystal Display (Fig12). The display is 16 character by 2 line display has a very clear and high contrast white text upon a blue background/backlight. This is great blue backlight LCD display. It is suitable for Arduino based project. This LCD1602 Parallel LCD Display with Yellow Backlight is very easy to interface with Arduino or Other Microcontrollers.

Fig .12 LCD Display

IV. COMPONENTS AND MATERIAL SELECTION

A. DESIGN AND CALCULATIONS

CALCULATION OF PNEUMATIC CYLINDER DIMENSIONS

Assumption: Maximum force acting on bumper is assumed to be 90N[5]
Factor of safety as 1.25
Bumper to be designed for 90x1.25 =112.5N force
Pressure to be used is 4bar=0.4N/mm2

a) For Applying Brakes:

For out-stroke
Force= P x A
112.5= 0.4 x 0.79 D
D2 = 358.09 mm2
So, D =18.92mm
Selecting standard value of 20mm bore diameter,
To calculate the inner diameter.
Assuming In-stroke force to be equal to outstroke force,
we assume in stroke force to be 90N.
For factor of safety of 1.25, in stroke force is 90x1.25=112.5N.
For in-stroke,
Piston rod area = π/4 x d2
Effective area = π/4 x (D2-d2) = 0.79 (202-d2)mm2
So, Force = 0.4 x 0 .79(202-d2)
112.5 = 0.32(202-d2)
On solving, we get d= 6.47mm Hence, selecting from standard values, inner diameter is 8mm.
Keeping stroke of 50mm for applying brakes, we get the cylinder dimensions as,
Cylinder bore = 20 mm
Cylinder stroke =50mm

b) For Bumper:

For out-stroke
Force= P x A
112.5= 0.4 x 0.79 D
D2 = 358.09 mm2
So, D =18.92mm
Selecting standard value of 20mm bore diameter,
To calculate the inner diameter.

Assuming In-stroke force to be equal to outstroke force,
we assume in stroke force to be 90N.
For factor of safety of 1.25, in stroke force is 90x1.25=112.5N.
For in-stroke,
Piston rod area = π/4 x d2
Effective area = π/4 x (D2-d2) = 0.79 (202-d2) mm2
So, Force = 0.4 x 0 .79(202-d2)
112.5 = 0.32(202-d2)
On solving, we get d= 6.47mm Hence, selecting from standard values, inner diameter is 8mm.

Keeping stroke of 100 mm for bumper, we get the cylinder dimensions as,
Cylinder bore = 20 mm

Cylinder stroke=100mm
Force of cylinder = pxπ/4 x d2 S
= 21.46 pounds=9.73kg
Weight of the bumper = 2kg
The above cylinder force is enough to pull the bumper forward

B. CALCULATION OF PNEUMATIC COMPRESSOR

TABLE 2
Flow rate required to activate the cylinders [1],

Description	Cylinder 1	Cylinder 2	Unit
A = Piston Area	0.48	3.89	Square inches
S = Stroke	50	100	Inches
C = Cycles per Minute	2	2	no's
CFM = (A x S x C) / 1728	0.11	0.45	CFM
	3.11	12.74	Lit/minute
Total flow rate required to activate the cylinders	**15.85**		Lit/minute

Total flow rate required to activate the cylinders = 16 Lit/minute.
A compressor with a capacity of 20Lit /min to be selected

C. CALCULATION OF DC MOTOR

Power required
P=Ft.v./Eff.
Assume, constant speed = 10km/hr
= 2.78m/s
Weight of the vehicle =30kg
Tractive force Ft=Fr+Fg+Fd+Fie
Assume, Gradient resistance force and aerodynamic drag resistance as Zero.
Rolling resistance R=Fr.G

Since nylon tyre to be used, Consider coefficient of rolling resistance as 0.04.
R= 0.04*(30x9.81)=11.772N
Ft=11.772N

Power required P=Ft.v/Efficiency
=(11.772*2.78)/0.85
=38.5W
Power required from the motor=38.5W
A 12V motor with 4.8A to be selected (57 watts).

D. DESIGN OF PROTOTYPE MODEL

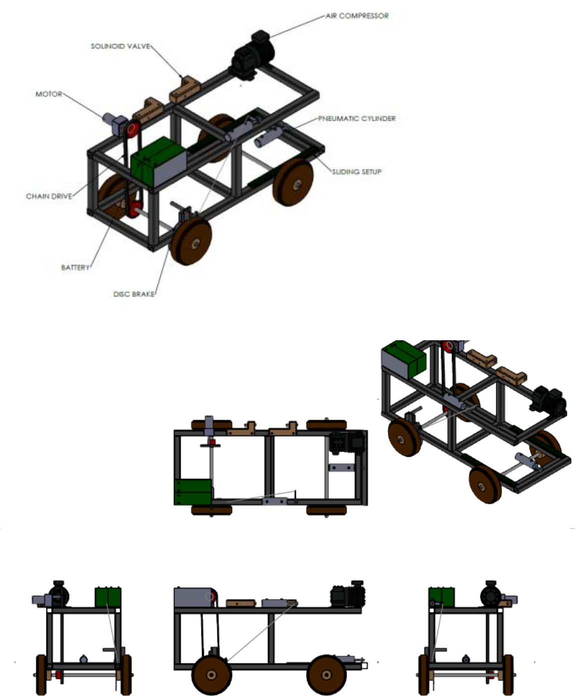

Fig .13 Prototype design model

V. PROJECT CONSTRUCTION AND FABRICATION

A. PROJECT CONSTRUCTION STEP

Step 1:
First, frame is made to mount the important elements. For making the frame, mild steel pipes was used (rectangular cross section) for better strength and load taking capacity. The frames were welded together using arc welding process. Then bumper activation cylinder welded to the frame. Sliding channels also welded to the frame to guide the bumper during movement. Then bumper is attached to the cylinder as shown in Fig.14.

Step 2:
Four 6 inch wheels are bushed and attached to the frame by means ball bearings. The front axle and rear axle shaft are inserted into the wheels. A 12v DC motor is clamped to the top frame by M5 screws as shown in Fig .15.

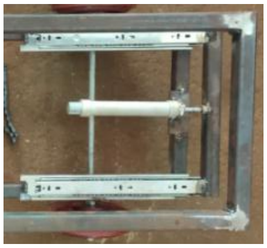

Fig .14 Cylinder and bumper assembly

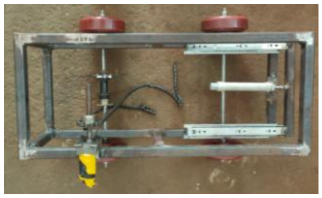

Fig .15 Bumper assy.

Step 3:

Brake disc with sprocket is attached to the rear axle by a nut as shown in Fig.16. The disc and rear axle made as a single unit and the sprocket assembly will rotate along with the rear axle shaft. The caliper is attached to the frame using supports and screws**.**

Step 4:

Compressor is bolted to the top of the frame by using screws. The motor output shaft is connected to the sprocket and chain is connected to the top and bottom sprockets as shown in Fig .17.

Step 5:

5/2 solenoid valve is fitted to the top frame using screws as shown in Fig.18. Then pneumatic hose connections are done. Brake cylinder also welded to the top frame and brake cable connected to the cylinder.

Step 6:

Assembly of Arduino,LCD display and Relay on printed circuit board. Terminals from IR ,D6T and speed sensor connected to the input of Arduino as shown in Fig.19.

Fig .16 Sprocket Assembly

Fig .17 Compressor mounting

Fig .18 Sol.valve assy.

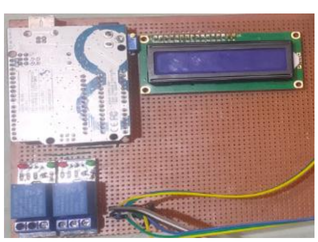

Fig .19 PCB mounting

Step 7:

Mounting of IR speed sensor (Fig.20)and disc connected to the motor shaft. Motor speed controller is connected between motor and battery terminals (Fig21).

Step 8:

Mounting of D6T thermal sensor and IR sensor on frame(Fig.22).

Fig .20 IR speed sensor

Fig .21 Motor speed controller

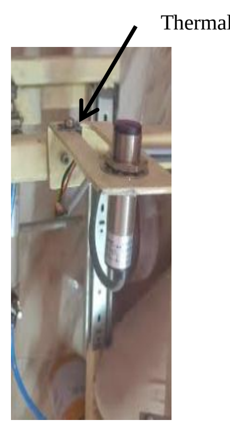

Fig .22 Thermal sensor

B. Electrical Wiring

1. The positive and negative terminal of the battery connected to a motor speed controller. Positive terminal of the motor is connected to respective terminal of the speed controller. When motor is switched on the speed can be controlled by speed controller using PWM.

2. The D6T thermal sensor has four terminals. Power supply pin and GND supply pin are connected to the battery.SDA &SDL are 5v supply pins connected to the Arduino.
3. The photo sensor has three terminals black, brown and blue.
i) Brown is the positive terminal connected to positive end of the battery.
ii) Blue is the negative terminal connected to negative end of the battery.
iii) Black is the output terminal connected to the positive terminal of the 12V relay.
4. The IR speed sensor has three terminals Vcc connected to the power supply, GND connected to the ground supply and OUT pin connected to the Arduino board.

5. Two 5v relay are connects Arduion board to the solenoid coil. When the turns from NO to NC the solenoid get energized.
6. Compressor terminals are connected to the positive and negative terminal of the battery.
7. Arduino programming is done after all the electrical connections are completed(Fig.23).

C. ARDUINO PROGRAMMING

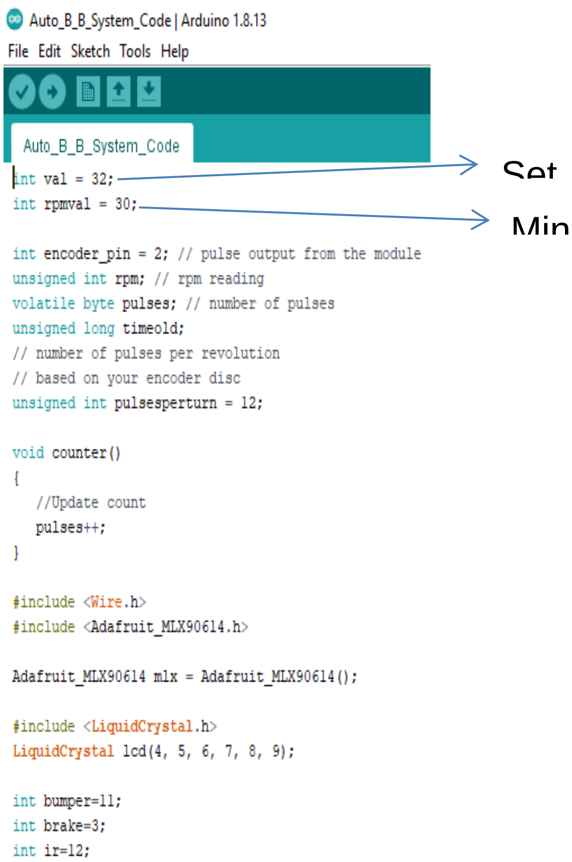

Fig .23 Arduino program

D.WORKING

i)Positive and negative clips are connected to the battery terminals.Now the motor and Arduino unit is swithed ON. The speed of the motor can be adjusted from 0 rpm to 100 rpm by rotating the rheostat (PWM).
ii) Then switch on the compressor button so that it could supply the system with atmospheric air at required pressure.
iii)The working IR speed sensor and LCD display checked. The rpm value changes with respect to motor speed

Total no.of teeth-12
Each teeth – 15deg, Each blank--15deg
Total teeth degree – 12*15 =180deg
Total blank degree – 12*15 =180deg
Total degree for one rotation=360deg
If the motor is running at 30rpm
One revolution of motor =12pulse
30rpm gives =30*12=360pulse per minute
1hertz=no.of cycles per second
No.of pulse per second =360/60=6
For , 30rpm , Speed sensor generates 6hz.
For,100rpm,Speed sensor generates 18hz**.**

Case 1: When there is no interruption in vehicle’s path
- At this situation, the vehicle will continue to move to its intended path without any interruption

Case 2: When there is an interruption in vehicle’s path at low speed
- The motor speed is set to <30rpm
- Compressor is switched on
- An obstacle is placed in front of the vehicle
- At this situation, the photo sensor placed over the frame receives a change in resistance due to interruption of the transmitter signals received by the receiver when the distance between the sensor and obstruction is less than 300mm.
- But, the speed of the motor is less than 30rpm which means the system should not work. At this situation, the vehicle will continue to move to its intended path without any interruption.

Case 3: When there is an interruption in vehicle’s path at high speed
- The motor speed is set to >30rpm
- Compressor is switched on
- An obstacle is placed in front of the vehicle
- At this situation, the photo sensor placed over the frame receives a change in resistance due to interruption of the transmitter signals received by the receiver when the distance between the sensor and obstruction is less than 300mm.
- As the speed of the motor is greater than 30rpm, Photo sensor directs the relays to do their functions which are to provide command to the solenoid valve so that the compressed air can be transferred to the two cylinders.
- This results in stopping of the device by application of brake and along with bumper ejection such that the impact by the accident could be decreased.
- At the same time the timer module starts counting and after 10secs the the brakes are release and the bumper is retracted.

Case 4: When there is an Human interruption in vehicle's path at high speed

- The motor speed is set to >30rpm
- Compressor is switched on
- A human presence is observed in front of the vehicle
- At this situation, the human sensor (D6T thermal sensor) placed over the frame receives a change in resistance due to interruption of the transmitter signals received by the receiver when the distance between the sensor and obstruction is less than 300mm.
- As the speed of the motor is greater than 30rpm, Thermal sensor directs the brake relay to do its function which is to provide command to the solenoid valve so that the compressed air can be transferred to the brake cylinders.
- This results in stopping of the device by application of brake and bumper ejection doesn't happen as that would harm the human.
- At the same time the timer module starts counting and after 10secs the the brakes are release and the bumper is retracted.

E.FINAL PROTOTYPE MODEL

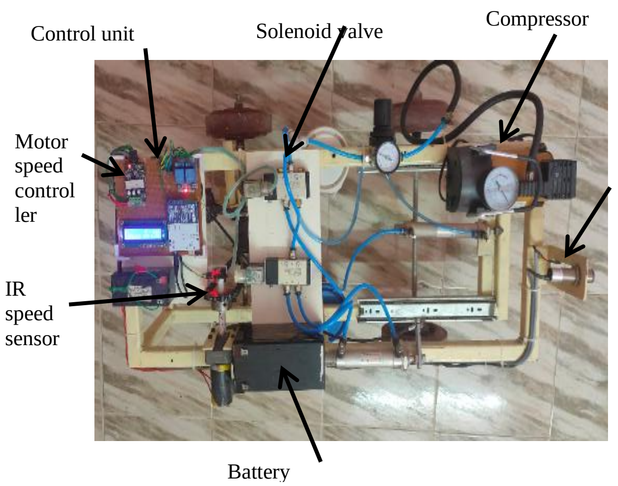

Fig .24 Final prototype model

VI. RESULTS AND DISCUSSION

A. Stopping distance and time for various obstacles:

In this project, working of the system is checked by placing various objects ahead as obstacles. The system responded by automatically stopping the vehicle. Vehicle was made to run at constant speed of 3.44kmph and different types of obstacles are placed in the vehicle path at a distance of 200mm.The sensor was able to sense all types of obstacles and vehicle stopped immediately. The response times for all types of obstacles are almost similar. The stopping distances for various objects are from 50 to 52mm as shown in Fig.25.

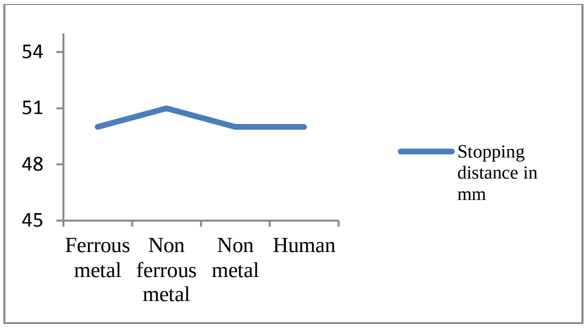

Fig .25 Obstacle Vs Stopping distance

The stopping times for various objects are almost similar. The stopping time varies from 0.15 to 0.17seconds as shown in Fig .26.

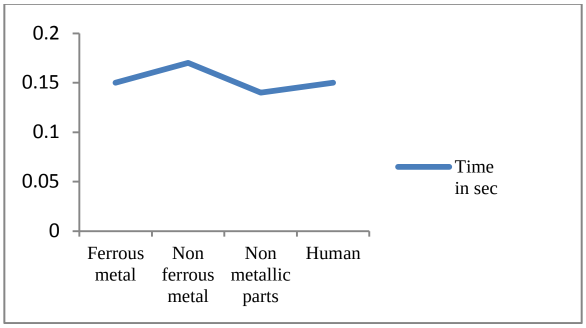

Fig .26 Obstacle Vs Stopping time

B. Stopping distance and time for various sensing ranges

The working of the system is checked by placing obstacles at various distances. The obstacles placed at 50mm, 100mm, 150mm, 200 & 250 and tested. The system responded by automatically stopping the vehicle. At 50mm distance range the vehicle couldn't stop, since the stopping distance and obstacle distance are same. During this time the bumper extracted and hit the obstacle and the vehicle body was not damaged. Thus the designed bumper system effectively working under this situation. From 100mm-250mm range the vehicle stopped before hitting the obstacle and the stopping distance is same. Fig.27 shows the stopping distance obtained various ranges. The stopping distances for various sensing ranges are almost same. Fig.28 shows the stopping time obtained for various ranges. The stopping time for various sensing ranges are almost same i.e. the stopping time is same for different range.

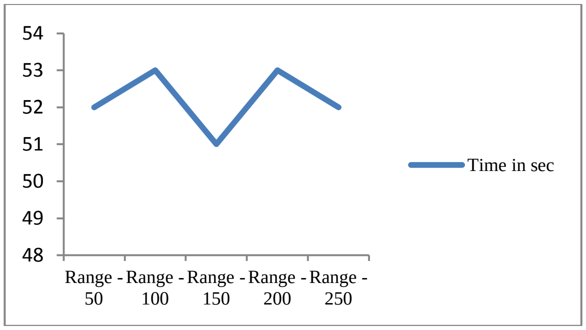

Fig .27 Range Vs stopping distance

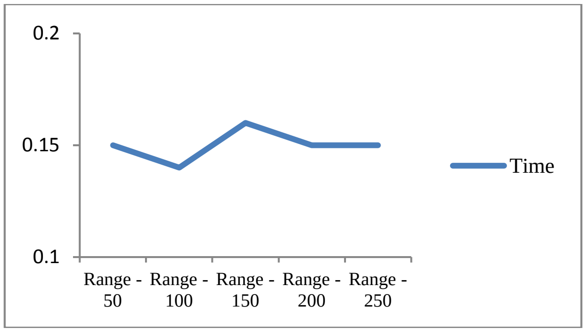

Fig .28 Range Vs Stopping time

C. Stopping distance and time at different vehicle speed

The prototype vehicle runs at 3.44kmph and the stopping distance and time for the vehicle at this particular speed is 58cm and 0.12s respectively. The graph is plotted for stopping distance and speed if the vehicle speed increased to 5, 10,15 and 20kmph.From the graph, this system will be able to stop the vehicle by brake up to 8kmph speed and beyond 8kmph the system will not be able to stop the vehicle. Since, the stopping distance is more than 0.4m which is more than the sensing range of 0.3.m the vehicle couldn't stop. Fig.29 shows the stopping distance calculated for different speeds. The stopping time increases linearly as the vehicle speed increases. Fig.30 shows the stopping time estimated for different vehicle speeds.

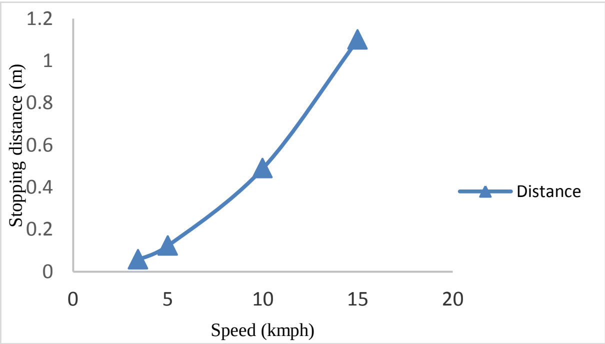

Fig .29 Speed Vs Distance

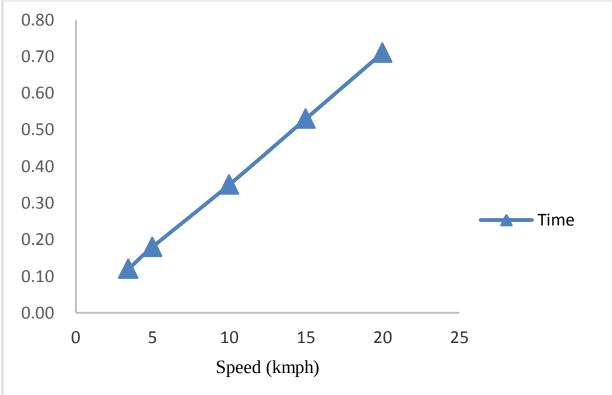

Fig .30 Speed Vs Time

VII. CONCLUSION

When employing this system on the main cars the functions of the system are specified below:

1. The minimum car speed should be 30Km/hr else the system won't be working.
2. The Pneumatic bumper system will only work if there will be any major obstructions such as a tree or another vehicle or any other obstruction that could lead to accident.
3. When the obstruction is a human being, the only function that will happen is the immediate braking and not the bumper actuation as the bumper actuation could harm the human being on the road.
4. In actual model, the range at which the brakes and bumper will be activated is calculated by a computer (approximately <40 m at a speed of 80-90Km/h), also the sensor will warn the driver at an appropriate distance (according to speed) at which the driver could act and if not responded, the system would take the handles on its own.

The project "Development of an Automatic Bumper and Braking System for Vehicles Using Pneumatic System to Avoid Collision" is working in satisfactory conditions. This project enables to understand the difficulties in maintaining the tolerances and also quality. The project fabrication and testing have been done to the ability and skill making maximum use of available facilities.

In conclusion remarks, few more lines about the impression project work,

1. The application of pneumatics produces smooth operation.
2. By using more techniques, they can be modified and developed according to the user.
3. This project is reliable; hence the passengers can rely upon their safety.
4. This project consists of the various parameters which the consumer of the car seeks during the purchasing of new car which should be under his budget and should provide continuously consistent result and should be reliable as well.
5. The project will not only protect the car from accident but also if the other car during the accident doesn't controls itself from the impact of accident, the bumper of the car will eject automatically to prevent the effects of the accident.

6. Other from the aspect of the use of the project in a specific location of application, it can also be used in many other places. In the industries where there is use of manual labours near the machines such as power plants, manufacturing industries, etc.
7. Also when we will be using our project in the real environment i.e. in the automobiles we have to place a computer such that it could adjust the working range of the sensors according to the real time conditions.
8. The project can be implemented to all the cars for the purpose of safety of each and every car.

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